HAMMER

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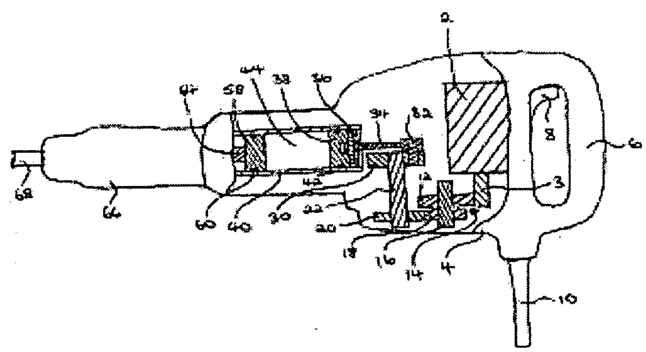
Abstract of **WO03041915**

A hand held motor driven electrically powered hammer, comprising an air cushion hammering mechanism in which an air cushion (44) is formed between a piston (38) and a ram (58) and a crank drive arrangement for converting a rotary drive from the motor (2) to a reciprocating drive to the piston (38). An intermediate gear arrangement (14) is provided between the motor (2) and the crank drive arrangement for transmitting rotary drive between the motor and the crank drive arrangement. The crank drive arrangement comprises a con-rod (34), which is made of a plastics material and is designed to break when the air cushion (44) between the piston and the ram deteriorates. In this way the hammer fails by the relatively weak con-rod (34) failing when the air cushion deteriorates due to deterioration of the seals between the piston and the hollow spindle and the ram and the hollow spindle. The failed hammer can be serviced by replacing the con-rod and seals, thereby delaying irreparable failure of the hammer due to repeated impacts between the piston and ram.



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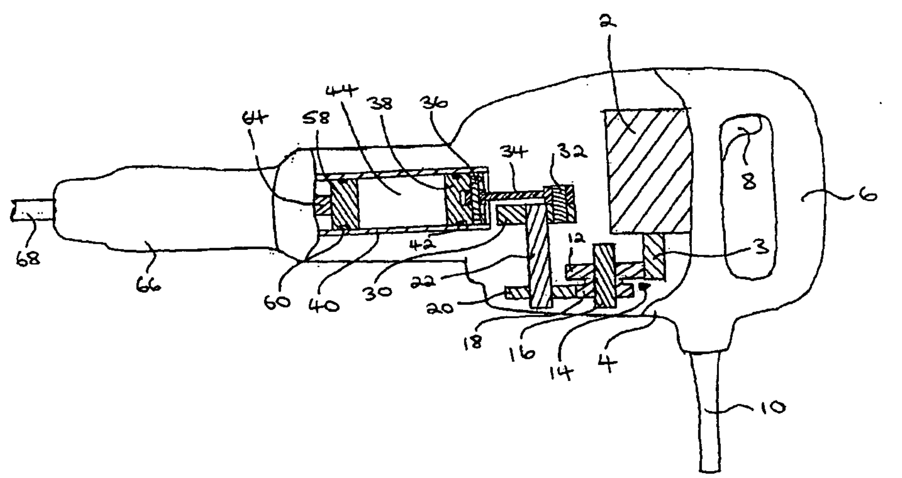

(57) Abstract: A hand held motor driven electrically powered hammer, comprising an air cushion hammering mechanism in which an air cushion (44) is formed between a piston (38) and a ram (58) and a crank drive arrangement for converting a rotary drive from the motor (2) to a reciprocating drive to the piston (38). An intermediate gear arrangement (14) is provided between the motor (2) and the crank drive arrangement for transmitting rotary drive between the motor and the crank drive arrangement. The crank drive arrangement comprises a con-rod (34), which is made of a plastics material and is designed to break when the air cushion (44) between the piston and the ram deteriorates. In this way the hammer fails by the relatively weak con-rod (34) failing when the air cushion deteriorates due to deterioration of the seals between the piston and the hollow spindle and the ram and the hollow spindle. The failed hammer can be serviced by replacing the con-rod and seals, thereby delaying irreparable failure of the hammer due to repeated impacts between the piston and ram.

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HAMMER

This invention relates to a hand held electrically powered hammer having an air cushion hammering mechanism driven by a crank drive system, and in particular to a demolition hammer.

Such hammers generally comprise a housing within which is located an electric motor and a crank drive arrangement for converting the rotary drive of the motor to a reciprocating drive to drive a piston, which piston is located within a hollow cylinder or spindle. The spindle is located within the hammer housing. The rotary drive from the motor can be used to directly drive a crank system drive shaft or can be used to indirectly drive a crank system drive shaft via an intermediate gear stage. The crank system drive shaft rotatingly drives a crank plate on which is mounted an eccentric crank pin. A crank arm or con-rod, which may be made of metal or plastic, is pivotally fitted at one end to the crank pin and at its other end to the rearward end of the piston. Thus, when the crank plate is rotatingly driven by the motor the crank arm reciprocatingly drives the piston within the spindle.

The spindle may be formed from a single part or from more than one part, for example from a rearward hollow cylinder, within which a piston and ram reciprocate and a forward cylindrical tool holder body, within which a tool or bit may be releasably mounted. A seal is provided around the periphery of the piston in order to provide an air tight seal between the piston and the spindle. A ram is located in front of the piston within the spindle and a seal is provided around the periphery of the ram in order to provide an air tight seal between the ram and the spindle. Thus, in normal operating conditions, a closed air cushion is generated within the spindle between the piston and the ram. The reciprocation of the piston reciprocatingly drives the ram via the air cushion. A beatpiece is generally located forwardly of the ram and transmits repeated impacts that it receives from the ram to a tool or bit releaseably mounted for limited reciprocation in a tool holder body. The impacts on the tool or bit are transmitted to a workpiece against which the tool or bit is pressed in order to break up or make a bore in the workpiece.

Some hammers are designed with a hollow piston air cushion hammering mechanism in which a hollow piston is driven reciprocatingly by a crank drive system. The present invention is also applicable to such hammers.

Some hammers may also be employed in combination impact and drilling mode in which the tool holder body, and hence the bit inserted therein, will be caused to rotate at the same time as the bit is struck by the beatpiece. The present invention is also applicable to such hammers.

One problem with such hammers is that after sustained use the seals surrounding the piston and/or the ram can become worn and the air cushion between the piston and the ram deteriorates until impacts begin to occur repeatedly between the piston and the ram. If such impacts between the piston and the ram occur repeatedly, then catastrophic damage can be caused to the hammering mechanism, which damage is not easily repaired. Such, damage may end the working life of the hammer. When the air cushion deteriorates there is an increased strain on the components between the motor and the piston for converting the rotary drive of the motor to a reciprocating drive of the piston. In particular, where there is a direct drive from the motor pinion to a gear on a crank drive shaft, there are high levels of strain on a small number of teeth on the gear and the pinion. Thus, as the air cushion deteriorates, the teeth can gradually shear over time, eventually causing failure of the drive to the hammer mechanism. This mode of failure can cause severe damage to components within the hammer housing due to the metal shavings which are generated when the teeth shear becoming caught between moving components of the hammer.

This problem has been overcome in the past, as described in US4,732,219 and US4,192,391 by causing a portion of the piston to break away from the remainder of the piston when impacts occur between the piston and ram. The portion of the piston that breaks away vents and thereby destroys the air cushion between the piston and the ram. Thereafter, the ram is prevented from being drawn rearwardly into the path of the reciprocating piston and so further impacts are avoided. Thus, catastrophic failure of the hammer is delayed. However, the hammer will not work again until it has undergone servicing, which servicing is non-routine as it will require replacement of the piston. One problem of these solutions is that debris generated by the breakage of the piston is located in the interior of the spindle and so can cause damage to the

interior of the spindle and/or the ram. The portion of the piston that breaks away must be retrieved during the servicing and may be difficult to locate. In addition, some impacts between the piston and the ram occur from time to time during normal operation of hammers. If such impacts cause the piston to break and stop the hammer mechanism this can be very disruptive to a user of the hammer, who will have to have the hammer serviced before it can be used again.

The present invention aims to overcome at least some of the problems discussed above by providing a hammer which delays catastrophic failure of the hammer by routine servicing procedures.

According to a first aspect of the present invention there is provided a hand held motor driven electrically powered hammer, comprising:

an air cushion hammering mechanism in which an air cushion is formed within a hollow spindle between a piston and a ram; and

a crank drive arrangement for converting a rotary drive from the motor to a reciprocating drive to the piston;

characterised in that an intermediate gear arrangement is provided between the motor and the crank drive arrangement for transmitting rotary drive between the motor and the crank drive arrangement and the crank drive arrangement comprises a con-rod which is made of a plastics material and the con-rod is designed to break before any other component of the hammer when the air cushion between the piston and the ram deteriorates.

When the air cushion between the piston and the ram starts to deteriorate there is an increased stain on the crank drive arrangement and the intermediate gear arrangement. Due to the use of an intermediate gear arrangement between the motor and the crank drive arrangement the drive to the con-rod is relatively robust and can withstand a relatively high amount of strain. As the air cushion between the piston and ram deteriorates and before repeated impacts between the piston and ram cause severe damage to the hammer, the plastic con-rod fails, by breaking, before any other component. The plastic con-rod is designed to be the weakest component in the drive system between the motor and the piston. The failure of the piston causes the hammer mechanism to stop operating and so no further damage to the piston, ram or intermediate gear arrangement are caused. Due to the position of the con-rod within

the hammer housing and because the con-rod is made of a plastics material, minimal damage is caused to adjacent components by any debris generated when the con-rod breaks. The hammer can then be serviced by replacing the con-rod and at the same time replacing the seals on the piston and ram. Thereby, the air cushion between the piston and the ram is restored. Servicing by replacing the seals around the piston and ram and by replacing the con-rod is relatively routine.

The con-rod may be made from a fibre reinforced plastics material, which may be fibre reinforced polyamide, and the fibres may be carbon fibres. The con-rod is preferably made using an injection moulding process with an entry point in the mould located mid-way between the ends of the con-rod. This ensures that the con-rod fails by snapping at its mid-point due to the resulting structural weakness there. Snapping at the mid-point is further ensured because this is the part of the con-rod which has to withstand the highest level of strain.

In a preferred embodiment of the present invention which provides a particularly robust design of intermediate gear arrangement, the intermediate gear arrangement is rotatingly mounted on a spindle rigidly mounted in the hammer and comprises a first gear wheel rigidly fixed to, or integrally formed with, a co-axial second gear wheel, wherein the first gear wheel engages and is rotatingly driven by a pinion of the motor and the second gear wheel engages and rotatingly drives a crank drive gear of the crank drive arrangement.

The hammer may additionally comprise a tool holder located at the forward end of the spindle in which a tool or bit may be releasably mounted for limited reciprocation wherein the reciprocation of the piston reciprocatingly drives the ram via the closed air cushion such that repeated impacts from the ram are transmitted to a tool or bit mounted in the tool holder body. It is also preferred that a beatpiece is located between the ram and the tool or bit for transmitting impacts therebetween.

According to a second aspect of the present invention there is provided a method of servicing a rotary hammer of the type defined above, comprising the steps of:

replacing the con-rod;

replacing the seal surrounding the piston; and/or

replacing the seal surrounding the ram.

One form of rotary hammer according to the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows a partially cutaway longitudinal cross section through a demolition hammer according to the present invention; and

Figure 2 shows a perspective view of the plastic con-rod used in the hammer of Figure 1.

The hammer shown in Figure 1 comprises an electric motor (2), an intermediate gear arrangement and a crank drive arrangement which are housed within a metal gear housing (not shown) surrounded by a plastic housing (4). A rear handle housing incorporating a rear handle (6) and a trigger switch arrangement (8) is fitted to the rear of the housing (4). A cable (not shown) extends through a cable guide (10) and connects the motor to an external electricity supply. Thus, when the cable is connected to the electricity supply and the trigger switch arrangement (8) is depressed the motor (2) is actuated to rotationally drive the armature of the motor. The metal gear housing is made from magnesium with steel inserts and rigidly supports the components housed within it.

The motor pinion (3) is formed with teeth which engage the teeth of a first gear wheel (12) of an intermediate gear arrangement (14) to rotatingly drive the intermediate gear arrangement. The intermediate gear arrangement (14) is rotatably mounted on a spindle (16), which spindle is mounted in an insert to the gear housing. The intermediate gear arrangement (14) has a second gear wheel (18) which has teeth which engage the teeth of a crank spindle drive gear (20) to rotatingly drive the drive gear (20). The drive gear (20) is non-rotatably mounted on a crank drive spindle (22) which spindle is rotatably mounted within the gear housing. A crank plate (30) is non-rotatably mounted at the end of the drive spindle remote from the drive gear (20), which crank-plate is formed with an eccentric bore for housing an eccentric crank pin (32). The crank pin (32) extends from the crank plate into a bore at the rearward end (34a) of a con-rod or crank arm (34) so that the con-rod (34) can pivot about the crank pin (32). The opposite forward end (34b) of the con-rod (34) is formed with a bore through which extends a trunnion pin (36) so that the con-rod (34) can pivot about the trunnion pin (36). The trunnion pin (36) is fitted to the rear of a piston (38) by fitting the ends of the trunnion pin (36) into receiving bores formed in a pair of opposing

arms, which arms extend to the rear of the piston (38). The piston is reciprocally mounted in a cylindrical hollow spindle (40) so that it can reciprocate within the hollow spindle. An O-ring seal (42) is fitted in an annular recess formed in the periphery of the piston (38) so as to form an air tight seal between the piston (38) and the internal surface of the hollow spindle (40).

Thus, when the motor (2) is actuated, the armature pinion (3) rotatingly drives the intermediate gear arrangement (14) via the first gear wheel (12) and the second gear wheel (18) of the intermediate gear arrangement rotatingly drives the crank drive spindle (22) via the drive gear (20). The drive spindle rotatingly drives the crank plate (30) and the crank arm arrangement comprising the crank pin (32), the con-rod (34) and the trunnion pin (36) convert the rotational drive from the crank plate (30) to a reciprocating drive to the piston (38). In this way the piston (38) is reciprocatingly driven back and forth along the hollow spindle (40), when the motor (2) is actuated by depression of the trigger switch (8).

A ram (58) is located within the hollow spindle (40) forwardly of the piston (38) so that it can also reciprocate within the hollow spindle (40). An O-ring seal (60) is located in a recess formed around the periphery of the ram (58) so as to form an air tight seal between the ram (58) and the spindle (40). In the operating position of the ram (58), with the ram located rearward of venting bores (not shown) in the spindle a closed air cushion (44) is formed between the forward face of the piston (38) and the rearward face of the ram (58). Thus, reciprocation of the piston (38) reciprocatingly drives the ram (58) via the closed air cushion (44). When the hammer enters idle mode (ie. when the hammer bit is removed from a workpiece), the ram (58) moves forwardly, past the venting bores. This vents the air cushion and so the ram (58) is no longer reciprocatingly driven by the piston (38) in idle mode, as is well known in the art.

A beatpiece (64) is guided so that it can reciprocate within a tool holder (66) which tool holder is mounted forwardly of the spindle (40). A bit or tool (68) can be releasably mounted within the tool holder (66) so that the bit or tool (68) can reciprocate to a limited extent within the tool holder (66). When the ram (58) is in its operating mode and is reciprocatingly driven by the piston (38) the ram repeatedly impacts the rearward end of the beatpiece (64) and the beatpiece (64) transmits these

impacts to the rearward end of the bit or tool (68) as is known in the art. These impacts are then transmitted by the bit or tool (68) to the material being worked.

The con-rod (34) is formed with a circular recess at its rearward end (34a) which fits around the eccentric pin (32) on the crank plate (30). At its other forward end (34b) the con-rod (34) is formed with a circular recess within which is located the trunnion pin (36), which pin is fitted to the rear of the piston (38). The con-rod (34) is made of a plastics material, prefereably a fibre reinforced plastics material, for example polyamide reinforced with carbon fibre, specifically 20% carbon fibre. The con-rod is made by injection moulding. Preferably, the entry point in the mould through which the molten plastics material is shot is located mid-way between the two ends of the con-rod (34). This leads to a surface imperfection being located at the entry point, mid-way between the ends of the con-rod (34) where the con-rod snaps when it fails.

When the seals around the piston (38) and ram (58) become worn due to the repeated reciprocation of the piston and ram within the spindle (40) the air cushion (44) deteriorates. This is due to the leakage of air around the seals (60, 42) out of the air cushion (44) when it is under a high overpressure and into the air cushion (44) when it is under a low underpressure. This, in turn causes increased strain to be placed on the intermediate gear arrangement and crank drive arrangement between the motor (2) and the piston (38). The use of an intermediate gear arrangement (14) between the motor (2) and the crank drive (20, 22) provides a relatively robust design, which is able to operate without failing under the increased level of strain. Due to the use of a robust drive arrangement to the crank drive and due to the design of the plastic con-rod (34), the con-rod (34) is designed to be the first component of the hammer of Figure 1 to fail. The con-rod (34) fails by snapping in two at its mid-point. The failure of the plastic con-rod (34) does not generate damaging swarf, and so does not damage adjacent components of the hammer. The con-rod (34) is designed to fail before the piston (38) and ram (58) undergo repeated impacts and so the con-rod fails before irreparable damage is caused to the hammering mechanism by such repeated impacts of the piston and ram.

The hammer than has to be serviced. During the servicing, the con-rod (34) is replaced and the seals (42) and (60) are replaced. This is a relative routing service

procedure. After servicing, the hammer will continue to operate until once more the con-rod (34) fails due to wearing of the seals or some other component failure occurs. In this way catastrophic failure due to wear of the seals (42, 60) leading to repeated impacts of the piston (38) and ram (58) is avoided. Thereby, the operating lifetime of the hammer is extended by requiring only routine servicing procedures.

CLAIMS

1. A hand held motor driven electrically powered hammer, comprising:
an air cushion hammering mechanism in which an air cushion (44) is formed within a hollow spindle (40) between a piston (38) and a ram (58); and
a crank drive arrangement for converting a rotary drive from the motor (2) to a reciprocating drive to the piston (38);
characterised in that an intermediate gear arrangement (14) is provided between the motor (2) and the crank drive arrangement for transmitting rotary drive between the motor and the crank drive arrangement and the crank drive arrangement comprises a con-rod (34) which is made of a plastics material and the con-rod is designed to fail before any other component of the hammer when the air cushion (44) between the piston and the ram deteriorates.

2. A hammer according to claim 1 wherein the con-rod (34) is made from a fibre reinforced plastics material.

3. A hammer according to claim 2 wherein the con-rod (34) is mode from fibre reinforced polyamide.

4. A hammer according to claim 3 or claim 4 wherein the fibres are carbon fibres.

5. A hammer according to any one of the preceding claims wherein the con-rod (34) is made using an injection moulding process with an entry point in the mould located mid-way between the ends of the con-rod.

6. A hammer according to any one of the preceding claims wherein the intermediate gear arrangement (14) is rotatingly mounted on a spindle (16) rigidly mounted in the hammer and comprises a first gear wheel (12) rigidly fixed to or integrally formed with a co-axial second gear wheel (18) wherein the first gear wheel engages and is rotatingly driven by a pinion (3) of the motor (2) and the second gear wheel engages and rotatingly drives a crank drive gear (20) of the crank drive arrangement.

7. A hammer according to any one of the preceding claims additionally comprising a tool holder (66) located at the forward end of the spindle (40) in which a tool or bit (68) may be releasably mounted for limited reciprocation wherein the reciprocation of the piston (38) reciprocatingly drives the ram (58) via the closed air cushion (44) such that repeated impacts from the ram (58) are transmitted to a tool or bit (68) mounted in the tool holder body.

8. A hammer according to claim 7 wherein a beatpiece (64) is located between the ram (58) and the tool or bit (68) for transmitting impacts therebetween.

9. A rotary hammer substantially as hereinbefore described with reference to any one of the accompanying Figures.

10. A method of servicing a rotary hammer according to any one of the preceding claims, comprising the steps of:

replacing the con-rod (34);
replacing the seal (42) surrounding the piston (38); and/or
replacing the seal (60) surrounding the ram (58).

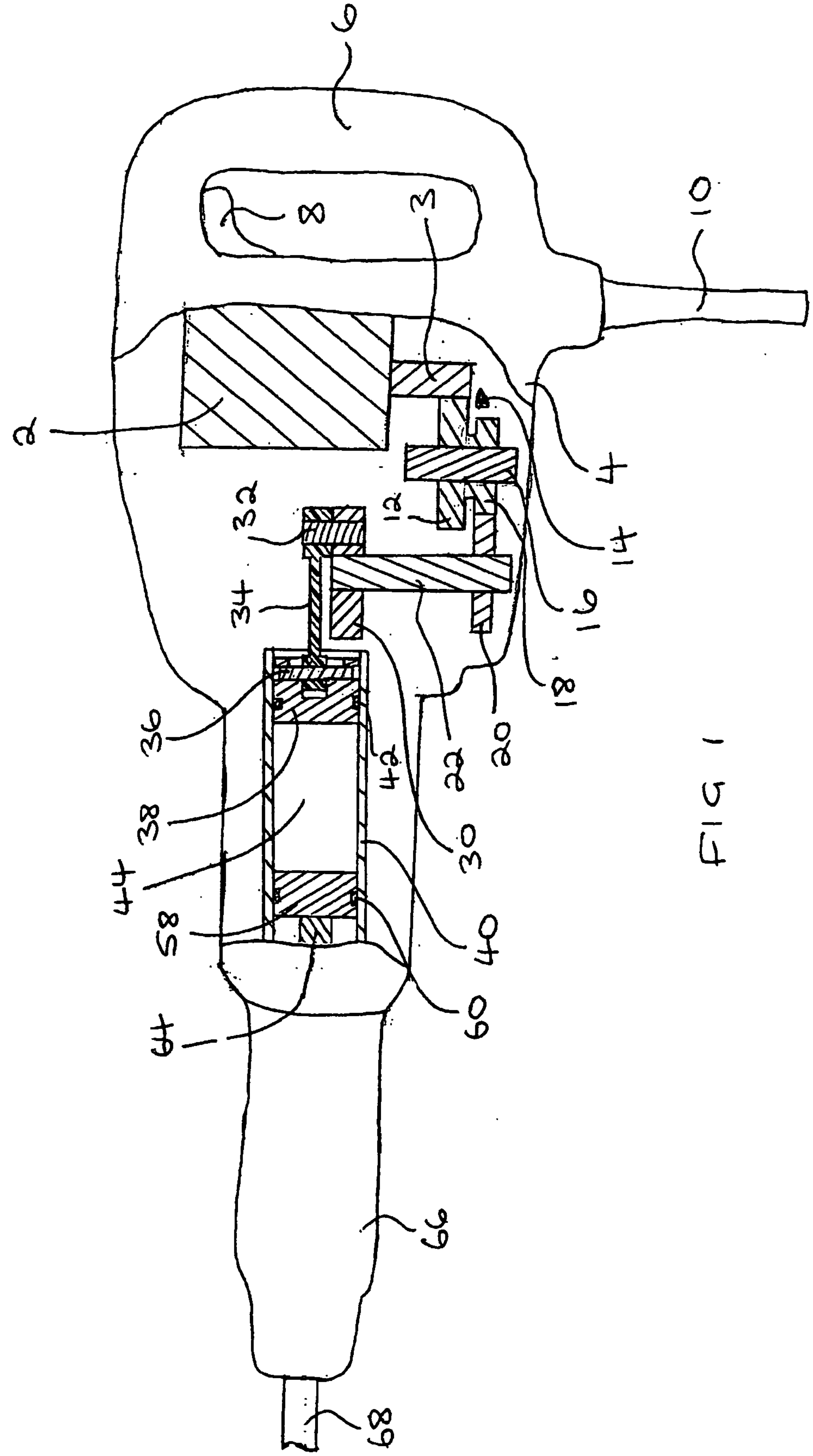

FIG 1

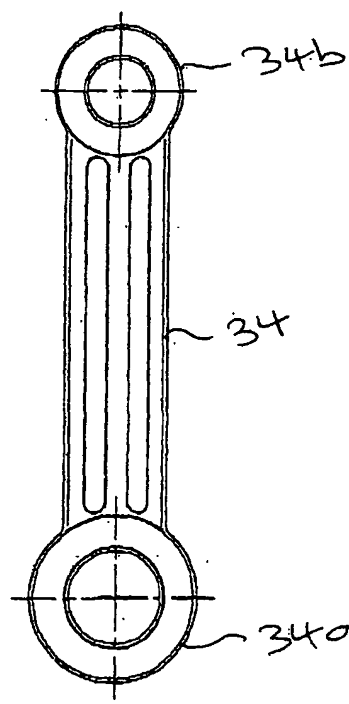

FIG 2.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 02/11961

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B25D11/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B25D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	GB 1 426 770 A (BOSCH) 3 March 1976 (1976-03-03) page 2, line 68 - line 74; figures 1-3 -----	1-3,5-7, 9 4,8,10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 February 2003	13/02/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bogaert, F

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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